ICHTHYOLOGY.—*Notes on the systematic status of four eel families.*[1]

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Certain aspects of the classification of the eel families Derichthyidae, Simenchelidae, Ophichthidae, and Chilorhinidae are taken up here. The last is proposed as new.

DERICHTHYIDAE

The species *Derichthys serpentinus* was described by Gill (in Goode and Bean, 1895: 161, fig. 169), who erected a new genus, family, and the new order Carenchelyi for it. However, subsequent authors have been unanimous in placing the species with other eels in the order Anguillida (or Apodes). Regan (1912: 386) has tentatively placed *Derichthys* in the Congridae, but Trewavas (1932: 641) and Beebe (1935) have retained a separate family for it. In the above works on *Derichthys* two points of disagreement have arisen: (1) whether the premaxillaries are separate from the vomer or whether they are fused with it, and (2) whether the frontals are ankylosed to form a single bone or whether they are separated by suture.

The type of *Derichthys serpentinus* consists of a skull 14 mm long, branchial arches, suspensoria, and pectoral girdles. In the skull the premaxillaries are ankylosed to one another but at present are free from the vomer. Gill stated that the premaxillaries were separated from the vomer by a suture, and I see no reason to doubt this despite the descriptions and figures of both Trewavas and Beebe. In fact, still another rather indefinite suture can also be made out in the type between the vomer and ethmoid.

A more unique feature among eels than the relationship between the premaxillary, ethmoid, and vomer in *Derichthys* is the maxillary articulation. This, instead of being at least in part medially with the ethmoid, is entirely forward, the front end of the maxillaries riding on sockets at either end of the transverse, premaxillary plate (Trewavas, 1932: 641, fig. 2).

As to the frontals, in the type specimen of *D. serpentinus* they are definitely ankylosed as stated by Beebe (1935: 9), and not paired as stated for *D. kempi* by Trewavas (1932: 641). This discrepancy, remarked upon elsewhere (Gosline, 1951a: 201), has been resolved by a recent letter from Trewavas. She writes: "I have examined the type of *Derichthys kempi* (Norman) and find that I had not slit the skin far enough to expose the frontals properly. I have now made a bigger slit and lifted the muscles and their raphe from the bones and I find that the frontals are united."

Benthenchelys, placed by Fowler (1934: 267) and Beebe (1935: 3) in the Derichthyidae, appears to be a congrid. *Gorgasia*, also placed in the Derichthyidae by Meek and Hildebrand (1923: 133) and Beebe (1935: 3), seems to be more nearly related to *Heteroconger*, which again may provisionally be considered a congrid.

SIMENCHELIDAE

The anatomical characters of this family, based on *Simenchelys parasiticus*, have been treated by Gill (1890), Regan (1912: 381), and Jaquet (1920).

As in the Derichthyidae the two premaxillaries are ankylosed, but this premaxillary plate, the ethmoid, and the vomer are again united by suture (Fig. 1). However, unlike *Derichthys* the maxillaries articulate with both the premaxillary plate and the ethmoid. In fact the relationships of all these bones of the snout area are exactly the same as those illustrated for the larval *Anguilla* by Trewavas (1932: 640, fig. 1). I think it may be assumed from these bone arrangements in the above two families and in the larval *Anguilla* that the ankylosis of the two premaxillaries to one another takes place earlier in life and occurred earlier in eel evolution than the fusion that gave rise to the premaxillary-ethmo-vomerine plate.

Again the question of fused *vs.* paired frontals has arisen in the literature on *Simenchelys*. Regan has indicated that the frontals of the Simenchelidae are paired. However, Jaquet (1920: 14) states that the frontals are ankylosed, as indeed they are in National Museum specimens. Once again this dilemma has been resolved by Trewavas. She writes (*in litt.*): "In our collection there is one specimen (N. Atlantic) partially dissected and this was probably the source of Regan's information. There is a median ridge in the frontal region which Regan may have interpreted as a suture but I can find no separation of the two bones."

[1] Contribution No. 19, Hawaii Marine Laboratory.

The presence of scales in one of the two genera of Simenchelidae and the maintenance of the premaxillaries, ethmoid, and vomer as separate entities are certainly primitive for eels. However, the small transverse mouth with its short, deep maxillaries and dentaries seems to be unique in the order; whether these structures are primitive or specialized seems impossible to determine.

Ophichthidae

The osteology of several Hawaiian genera of ophichthids has been recently discussed (Gosline, 1951b). The present section deals with *Echelus myrus* from the Mediterranean. In view of the peculiarities of this eel and of the fact that recognition or non-recognition of the family name Echelidae depends upon the systematic position of *E. myrus* (since this is the type species of *Echelus*), it will be described and figured in some detail.

External features.—Head and body elliptical in cross section, somewhat higher than broad; head and trunk shorter than tail. Dorsal and anal low, continuous around tip of tail, the dorsal beginning somewhat behind middle of the pectoral. Pectoral well developed, with 16 rays. Lateral line of body extending from in front of gill openings nearly to tip of tail, with about 137 pores. Gill opening wide, below pectoral base. Snout more or less acutely pointed, its length equal to about 2 eye diameters. Eye well developed, its posterior border slightly ahead of rictus. Lower jaw inferior. Lips without folds, the upper somewhat fringed just behind anterior nostril; both lips with innumerable microscopic papillae. Anterior nostril in a tube; posterior nostril opening partly on the lateral, partly on the lower surface of the upper lip, the lower opening caused by a flap which covers the anterior two-thirds of the lateral opening (Fig. 2a). The pore system differs from that of other ophichthids examined (Gosline, 1952b) in lacking postorbital pores, a posterior supraorbital pore, an interorbital pore on the middorsal line, and a transverse series across the nape (Fig. 2a). Teeth multiserial on dentaries, maxillaries, premaxillary plate (fused premaxillaries), and vomer. Teeth on maxillaries and dentaries all small, conical, blunt, and non-depressible; those on the premaxillary similar but slightly larger and with a single somewhat enlarged, fixed tooth behind; those on vomer still larger, granular, rising from a subovate plate which is broadest behind center. Color brown above, lighter below, with short, light bands on the head and several white spots on nape (these markings not indicated in Fig. 2a); dorsal and anal light anteriorly, with dark borders posteriorly.

Lateral-line canals.—The lateral-line canals of this species have been excellently described by Allis (1903: 131). Nothing need be added to this account except to point out that the course of these canals is about as in other ophichthids, even though several of the external pores found in other members of the family are not present in *Echelus*.

Jaw structure.—Lower jaw with the articular and angular fused as usually in eels. Premaxillaries ankylosed to one another and to the ethmovomer, the toothed surface of the premaxillary area forming an angle with the rest of the upper jaw (Fig. 2b). Anterior end of maxillaries articulating with the cranium at about the point of junction between the premaxillaries and vomer. Maxillary long, extending nearly to the articular-

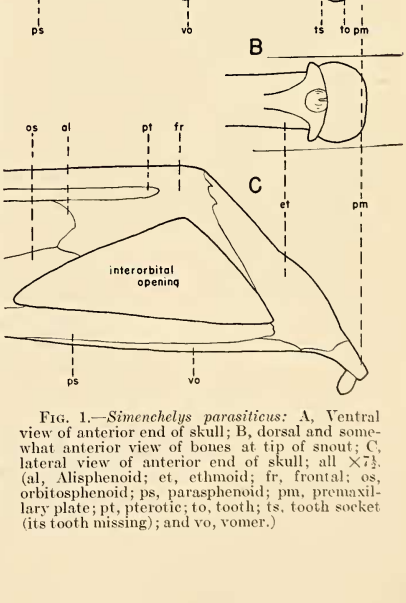

Fig. 1.—*Simenchelys parasiticus:* A, Ventral view of anterior end of skull; B, dorsal and somewhat anterior view of bones at tip of snout; C, lateral view of anterior end of skull; all ×7½. (al, Alisphenoid; et, ethmoid; fr, frontal; os, orbitosphenoid; ps, parasphenoid; pm, premaxillary plate; pt, pterotic; to, tooth; ts, tooth socket (its tooth missing); and vo, vomer.)

angular, to which it is closely attached by ligament, bearing multiserial teeth for nearly its entire length. There is a strong preorbital strut, apparently cartilaginous, between the maxillary and the cranium (Fig. 2b). In many, if not all eels in which the maxillaries are long and used for biting or crushing, a strut is developed between the maxillary and the cranium for support of the former. In the ophichthid *Brachysomophis* such a strut develops behind the eye from the postorbital lateral-line canal ossicles (Gosline, 1952b). The development of this strut in *Brachysomophis* has apparently pushed the eye far forward of its normal position in eels. In the muraenid *Gymnothorax funebris*, according to Fig. 82 of Gregory (1933: 202), both an antorbital and a postorbital strut are developed. Thus, maxillary supports of this type appear to be functional adaptations appearing here and there where needed among eels. However, the origin of the antorbital strut, where present, is dubious. That it is not an expanded lacrymal is indicated by its failure to bear any lateral line canal; that it is not a prefrontal is suggested by its apparently cartilaginous nature in *Echelus*.

Suspensorium.—This structure is somewhat forwardly inclined, less so than in *Conger* but more than in other ophichthids. Palatopterygoid laminar, well developed for eels, adjoining the quadrate posteriorly.

Opercular series.—Opercle well developed below but more or less truncated above. Preopercle moderately developed for eels and closely appressed to the posterior edge of the hyomandibular. Subopercle made up largely of a branchiostegal-like bone which encircles the lower edge of the opercle. Interopercle well developed, largely underlying the preopercle.

Gill arches.—Tongue not free. Branchiostegal rays 15 on each side, those of the two sides overlapping below. Openings between the gill arches wide, except the last. Upper pharyngeal ovate, with numerous conical teeth.

Cranium.—The skull of *Echulus* is long and moderately low, with an interorbital opening that is longer than deep. Unlike other ophichthids examined, the skull of *Echelus* is abruptly truncate posteriorly with a prominent edge above, as in *Conger*. There is a slight, longitudinal, median crest running along the ankylosed frontals. The ethmoid sends a triangular wedge over the anterior end of the frontals. A well-developed otic bulla present.

Axial skeleton.—On one of the first vertebrae (the only one examined) there is no neural crest. In this character *Echelus* like other ophichthids differs from the Congridae.

Pectoral girdle.—This structure, together with the pectoral fins, is fully developed for eels, with 4 well-formed actinosts.

Discussion of Echelus.—In that *Echelus myrus* bears a number of structures showing a closer resemblance than any other ophichthid to the relatively unspecialized Congridae (from which the Ophichthidae was undoubtedly derived), it may be said to be a primitive member of its family. Characters on which this statement is based are: suspensorium somewhat forwardly inclined; branchiostegal rays relatively few; skull abruptly truncate posteriorly; and pectoral girdle with four actinosts.

Characters in which *Echelus* appears to differ both from the Congridae and from other ophichthids are: external pores of the lateral line system of the head reduced in number; a middorsal crest on the skull; and an antorbital stay between the maxillary and the cranium.

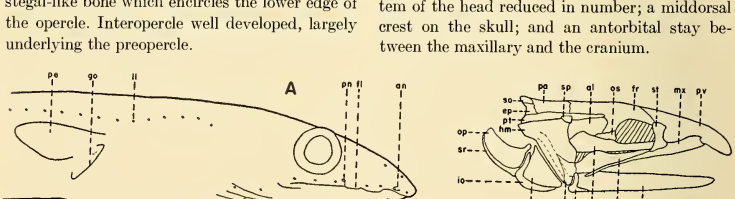

FIG. 2.—*Echelus myrus:* A, Lateral view of head region, × 4/5; B, lateral view of head skeleton (the teeth and branchial apparatus omitted), × 4/5. (al, Alisphenoid; an, anterior nostril; ar, articular-angular; da, dentary; ep, epiotic; fl, flap covering the anterior section of the posterior nostril; fr, frontal; go, gill opening; hm, hyomandibular; io, interopercle; mx, maxillary; op, opercle; os, orbitosphenoid pa, parietal; pe, pectoral fin; pn, posterior section of posterior nostril; po, preopercle; pp, palatopterygoid; ps, parasphenoid; pt, pterotic; pv, premaxillary-ethmovomerine plate; hu, quadrate; so, supraoccipital; sp, spenotic; sr, subopercle; and st, preorbital strut.)

Characters in which *Echelus myrus* is similar to other ophichthids but differs from *Conger* are as follows: posterior nostril opening out on the ventrolateral surface of the upper lip; tongue not free; branchiostegal rays of the two sides overlapping along the midventral line; otic bulla developed; and neural crests apparently absent.

In summary, *Echelus myrus* appears, despite specializations, to be by far the most primitive (or generalized) ophichthid known. In fact, to a considerable degree it fills in the gap between the Ophichthidae and the Congridae.

Within the Ophichthidae, on zoological grounds as well as for convenience in identification, two subfamilies should in my opinion be recognized: (1) the Echelinae (called Myrophinae by Gosline in previous papers) with the dorsal and anacontinuous around the tip of tail, and (2) the Ophichthinae with the tail protruding as a fleshy point. Both of these subfamilies contain very diverse eels and both include highly specialized members, but there is no known evidence that either is polyphyletic. Because of this diversity, the separation of *Echelus*, despite its peculiarities, from other fintailed ophichthids—*Muraenichthys*, *Myrophis*, etc.—as a third subfamily seems inadvisable at the present time.

Chilorhinidae, n. fam.

The family name Chilorhinidae is here proposed for a group of three eel genera: *Chilorhinus* Lütken (1851), *Garmanichthys* Seale (1917, of which *Arenichthys* Beebe and Tee-Van, 1938, appears to be a synonym), and *Kaupichthys* Schultz (1943). These three genera have generally been placed with *Echelus*, *Muraenichthys*, etc., in the family Echelidae. However, osteological investigation has shown that *Kaupichthys* (Gosline, 1950) and *Chilorhinus* (Gosline, 1951a) belong in a very different family from *Muraenichthys* (which is an ophichthid, Gosline, 1951b). At the time the above genera were investigated specimens of *Echelus* were unavailable to me, and the name Echelidae was provisionally retained for the family represented by *Kaupichthys* and *Chilorhinus*. That this use of the name Echelidae is untenable has been shown by the previous section of the present paper. The name Chilorhinidae is therefor substituted.

Examination of a specimen of *Garmanichthys apterus* indicates that this genus also belongs in the Chilorhinidae.

Though phylogenetically distant as has been previously pointed out, the chilorhinids bear a close superficial resemblance to the subfamily Echelinae of the Ophichthidae. The two groups can, however, be separated by a few minor superficial characters which may be tabulated as follows:

Chilorhinidae	Echelinae
Branchiostegal rays of the two sides (usually visible through the flesh of the "neck") never overlapping on the midventral line.	Branchiostegal rays of the two sides overlapping on the midventral line.
Vomerine teeth biserial, the two rows widely separated.	Vomerine teeth, if present, uniserial, in two or more irregular rows, or in a broad band.
Fin rays at the tip of the tail longer than the dorsal and anal rays preceding them.	Fin rays at the tip of tail usually shorter than the dorsal and anal rays preceding them.

The three known genera of Chilorhinidae may be separated as follows:

1*a*. Pectorals present, well developed (Indo-West-Pacific) ..... *Kaupichthys*
1*b*. Pectorals rudimentary or absent.
  2*a*. Lower lip with a well-developed flap on either side; snout broader than long (West Indies and Hawaii) ..... *Chilorhinus*
  2*b*. Lower lip without a downwardly-folded flap on either side; snout longer than broad (includes *Arenichthys;* both sides of tropical America) ..... *Garmanichthys*

Eel Classification

Recent examination of the osteology of certain eels (Gosline, 1950, 1951a, 1951b, and the present paper) has necessitated a shift in the systematic position of several eel families. Yet much remains to be done before any basic understanding of eel classification can be attained. Not only are we ignorant of the phylogenetic relationships of many eel groups and of the order Anguillida itself, but the present delimitation of many eel families is awry. On the one hand families have been erected for certain species on insufficient osteological evidence; on the other the Congridae continues to form a dumping ground for all sorts of creatures (including, as my contribution, *Benthenchelys*, *Gorgasia*, and the Macrocephenchelidae). At present then, it is impossible to do more than add to the classification of eels set up by Regan (1912).

So far as I can tell, this foundation remains sound; at the very least, a better one has never been proposed. The changes in classification necessitated by the recent work cited above can be integrated into the synopsis of eel families given by Regan (1912: 379) and amended by Trewavas (1932: 656) as follows:

1*a*. Caudal fin well developed and free from dorsal and anal. (A fossil group.).....URENCHELIDAE
1*b*. Caudal fin, if present, small, and generally continuous with the dorsal and anal.
2*a*. Frontals divided by suture, at least posteriorly.
3*a*. Frontals divided by a suture for their entire length.
4*a*. Jaws not produced.
5*a*. No expanded auditory bulla present ANGUILLIDAE, XENOCONGRIDAE, MYROCONGRIDAE, and MURAENIDAE
5*b*. Prootic and basioccipital forming an enlarged auditory bulla around a large otolith.
6*a*. Posterior nostril labial CHILORHINIDAE
6*b*. Posterior nostril on cheek HETERENCHELIDAE and MORINGUIDAE
4*b*. Jaws produced.....SERRIVOMERIDAE
3*b*. Frontals ankylosed anteriorly NEMICHTHYIDAE and CYEMIDAE
2*b*. Frontals ankylosed for their entire length.
7*a*. Maxillaries articulating only with lateral tips of premaxillaries....DERICHTHYIDAE
7*b*. Maxillaries articulating in part or entirely with ethmoid.
8*a*. Jaws strong; suspensorium vertical or directed obliquely forward.
9*a*. Caudal vertebrae without transverse processes above haemal arches.
10*a*. Maxillary articulating with ethmoid at some distance from end of snout.....MURAENESOCIDAE and NEENCHELIDAE
10*b*. Maxillary articulating with ethmoid near tip of snout.
11*a*. Mouth a small, transverse slit across front of head SIMENCHELIDAE
11*b*. Gape large; jaws long NETTASTOMIDAE and NESSORHAMPHIDAE
9*b*. Caudal vertebrae with transverse processes above the haemal arches.
12*a*. Posterior nostril superior or lateral. (The Heterocongridae and Macrocephenchelidae are provisionally included here.)..... CONGRIDAE
12*b*. Posterior nostril labial. (Includes Echelinae.)..... OPHICHTHIDAE
8*b*. Jaws slender; suspensorium directed obliquely backward .....ILYOPHIDAE, DYSSOMIDAE, and SYNAPHOBRANCHIDAE

I wish to thank Dr. L. P. Schultz for permission to examine skeletal material in the U. S. National Museum of *Simenchelys* and *Derichthys* reported on by Gill (1890 and, in Goode and Bean, 1895, respectively), together with a preserved specimen of *Garmanichthys apterus*. Through the kindness of Dr. G. S. Myers and J. Böhlke, a Stanford University specimen of *Echelus myrus* has been lent me; as this appears to be the only specimen of *Echelus* in America, I am particularly indebted to Dr. Myers for permission to dissect it partially. I also wish to thank Dr. E. Trewavas of the British Museum for examining specimens of *Derichthys* and *Simenchelys* for me.

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PROCEEDINGS OF THE ACADEMY

452d meeting of board of managers

The 452d meeting of the Board of Managers held in the Cosmos Club on January 14, 1952, was called to order at 8:03 p.m. by President-Elect Walter Ramberg. Others in attendance were: H. S. Rappleye, J. A. Stevenson, H. A. Rehder, Charles Drechsler, W. F. Foshag, A. T. McPherson, C. F. W. Muesebeck, Sara E. Branham, J. J. Fahey, E. H. Walker, Wm. A. Dayton, C. A. Betts, R. S. Dill, A. M. Griffin, Floyd Hough, M. A. Mason, F. M. Defandorf, and, by invitation, Margaret Pittman, J. R. Swallen, G. P. Walton, B. D. Van Evera, and G. H. Coons.

Chairman Walton presented the report of the Committee on Awards for Scientific achievement. Milton Seymour Schechter, of the Bureau of Entomology and Plant Quarantine, was nominated for the Award in the Physical Sciences; Edward William Baker, Bureau of Entomology and Plant Quarantine, for the Award in the Biological Sciences; and Max A. Kohler, of the Weather Bureau, for the Award in the Engineering Sciences. For the Teaching of Science, the first award of its kind to be requested of the Board since this award was approved in principle in 1950, the Committee recommended that in lieu of the regular award, which bears the age limitation of 40, a special award be presented to Howard B. Owens, biology teacher in the Hyattsville High School, for his outstanding teaching and for his work in arousing the enthusiasm of the students who come in contact with him. The Managers approved the granting of the awards as recommended.

Chairman Mason of the Committee on Encouragement of Science Talent spoke of activities in connection with the forthcoming 4th District Talent Search, the National Science Talent Fair, and the 5th Annual Science Fair to be held in Washington. Funds accruing from the Academy-sponsored benefit showing of the film Kon-Tiki should ease the financial problems that arise on these occasions where there is no obvious source of financial support.

The Secretary read a letter dated January 4, 1952, from N. R. Ellis, secretary-treasurer of the Society for Experimental Biology and Medicine, expressing the interest of this Society in becoming affiliated with the Academy. It was moved and approved that the President of the Academy appoint a special committee to consider the application and bylaws of the Society and make suitable recommendations to the Board.

The Secretary read a letter from the business manager of the American Association for the Advancement of Science, listing the following amounts available for Grants-in-Aid:

Balance for 1950	$4.50
For 1951	249.00
For 1952	246.00

making a total presently available of $499.50. The small amount remaining for 1950 will not be available unless expended before December 31, 1952.

Deaths were reported of Oscar B. Hunter, Sr., on December 19, 1951. and Rufus H. Sargent on December 28, 1951.

On request and recommendation of the Treasurer, Bertrand L. Johnson, who will retire in 1952 from the U. S. Bureau of Mines, was transferred to the retired list as of December 31, 1952.

Letters of resignation were received from Maxwell M. Knechtel, William Vogt, and L. E. Whittemore. Their resignations were approved as of December 31, 1951.

The Treasurer reported that his books had been audited for 1951 and the securities had been examined by the auditing committee.

Senior Editor Drechsler gave a statistical report on the content of the 1951 volume of the Journal and indicated that the net cost would be $6,500.76.

The meeting was adjourned at 9:15 p.m.

F. M. Defandorf, *Secretary*